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People Watcher: An App to Record and Analyzing Spatial Behavior of Ubiquitous Interaction Technologies

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ABSTRACT

In this paper we argue that interfaces embedded in the world, one of the core objectives of ubiquitous computing, require interaction designers and researchers to have a stronger understanding of the environment as an aspect of the interaction process. We suggest that the interaction community needs new tools to accurately record and, as importantly, analyze *interaction in space*. We present one solution: People Watcher, a freely downloadable, iPad Application, specifically designed to address the ‘usability in space’ issues. The paper reports a case study of the software’s use. We go on to encourage researchers to adopt this tool as part of the wider process of understanding the effect of the spatial context in interaction design.

Author Keywords

Experiment, tools, space, behavior, ubicomp, software

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

HCI has naturally centered, methodologically, on the human and the computer as foci of attention in the evaluation process. For many years, usability laboratories have sought to control any confounding effects of the environmental context by removing it or unifying them. In the previous ‘desktop era’, including the period of the Internet evolution, this was a highly valid and effective strategy. For Weiser [21], the future interaction paradigm was based on the use of technology embedded in the environment. Wisneski [24] and Ishii [12] discuss using information ‘situated in space’ as part of the interface. This has led others, such as Williams [22], to reconsider the role

of space in interaction. She states, “*Instead of thinking about ubiquitous computing in contrast to the desktop it leaves behind, our main focus is on the space into which computation will move*”. Brewer [3] observes, “*Questions of spatiality have long been of interest to HCI research, whether they concern the structure of virtual workspaces, the problems of collaboration at a distance, or the choreography of action on collocated environments*”. Yet, to date, little has been done regarding tools and theories to help analyze the impact of space. Recently space itself is seen as part of the interaction process; Ballendat et al. [1] offer the notion of proxemics as an interaction-mode. Specifically they are interested in technologies, which sense presence in space and use that to modify the kinds of information presented. From this, the occupation of space becomes an interactional element, which reinforces the urgency for space-based evaluations.

With the emergence of the design and evaluation of ubiquitous technology, we have begun to see the reporting of cases where traditional methods that exclude, or hold space constant, have failed. Hazelwood [11] reported on the difficulties of observing the usability of technologies embedded in the environment: specifically the problems of performing observations on ambient displays. Recently researchers have begun to report on the impact that spatial configuration has on the likely usage of an interface designed in an ambient context. Hornecker et al. [2] reported on an evaluation performed with families in, both a more controlled laboratory context and its use in the target spatial environment of a museum. This work reported that user behavior significantly changed due primary to the setting in which it occurred.

Ethnographically inspired observations, interviews and online questionnaires were used by Rogers et al. [18] to evaluate a large ambient display; while it was clear that the location of the display had an impact on its use, they failed to introduce an explicit methodology to permit accounting for the positioning of the ambient display. Fischer [8] introduced a method extending ethnographic approaches, which reported data introducing a taxonomy of spaces for large-scale, shared displays. While this taxonomy adds clarity, further research is required before it can produce statistically testable results. Scupelli [20] suggested using an architectural analytic-method, an isovist, to aid

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researchers understand visibility in a real environment. Parra et al. [16] also explores the role space has in the discovery of public displays citing [19] to the role that space plays in finding the right spot for maximizing display discovery. While this suggests that space can be considered part of a rigorous framework for usability research, it is under-developed. Our work sits on the border between ethnographic approaches used by [2][9] and the more digital approaches of observing aggregate pedestrian behavior such as the Bluetooth observation techniques of O'Neil et al. [15]. It is based on the paper methods used in Space Syntax and public displays [2] particularly those methods used to understand visitor movement through a museum described by Peponis et al. [17]. It is also meant to extend previous work with tools to support ethnographic observations in the field of behavioral observation such as described in [7] and [13]: these systems however have very poor ways of referring to special locations. It also differs from work on mobile eye-tracking such as [6] by being an external observation method not needing the participants to wear special equipment.

Most comparable to this work is that of Williamson & Williamson [23] who introduce a video based system to track the movements of users around a public display. While their system automatically traces user movement around the display it fails to provide any user interface to support the real time observation of user behavior around the interface in question.

QUANTATIVE SPATIAL UNDERSTANDING

Historically, methods for observing human behavior have improved in terms of accuracy, objectivity and level-of-detail. Furthermore, tools that permit an immediate synthesis of this data, providing rapid insights into observations, are emerging. The current HCI field would be hard to imagine without measurements and the statistical tools used to gain insight, yet, when it comes to the spatial environment, any associated methods tend towards the more qualitative and less quantitative.

Our contribution to the field is the development of a tablet-based App for researchers. The App partially emerged from a CHI Workshop on Architecture and Interaction [5] as a tool to promote the understanding of space in HCI. Current, paper-based techniques suggest that considerable interaction data needs to be recorded in a small amount of time. Our concern was that the demands of recording behaviors creates a situation where their spatial context is largely ignored or recorded in imprecise ways (e.g. "Near a door"). Current recording methods, we would suggest, conceal a wealth of potentially available information. Our objective was to increase the fidelity of recording interaction behaviors and, specifically, real-time recording of behaviors in space. Our aim was to provide a tool to accurately record and analyze live behavior in space.

As a user group, we worked with a team of environmental psychologists and architects in a participatory design process to help define the requirements of the software and as a resource to evaluate the results. As a profession, environmental psychology has a strong preoccupation with space and by working with this team we believed it would be possible to develop a tool that could enhance research across these fields. Environmental psychology is a field with similar aims of experimental rigor, as familiar to HCI researchers, but with slightly differing concerns and focii.

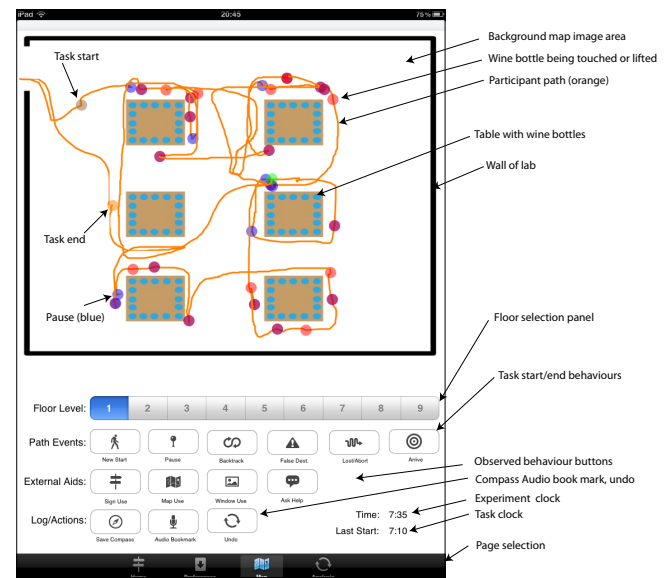


Figure 1 People Watcher Recording Page. (Orange line represents single participant path.)

Quite quickly in the design process it was thought that the use of mobile tablet technologies might offer something new and original over the paper methods generally used. Our reasoning was that the use of tablets is becoming a familiar sight and so having a researcher follow a participant through a space/setting would be less intrusive. Additionally, digital technologies permit the recording of behaviors with more fidelity, accuracy and lower error rates than paper. The digital data produced is more amenable to further processing and analysis. This note will describe our contribution, a software App called 'People Watcher' and its envisaged use. The paper will then continue to report on a case study of the software and end with clarification of the utility of looking at space in the interaction process.

PEOPLE WATCHER

Currently, this App is freely available on the iTunes App store. It can be found using the search term 'People Watcher'. It is currently under active development; facilities and capabilities may change as the App evolves. The App consists of five screens or 'pages': the Home/Participant Page; the Map Configuration Page; the Behavior Configuration Page; the Recording Page and the

Trail Analysis Page. Each of these will be described in detail, through describing an expected, typical workflow.

The Map Configuration Page

Before an experiment begins it is necessary to import an electronic plan of the building, room or space, which is the setting for the HCI experiment. People Watcher is configured to handle multi-floor buildings, with each floor as a separate image. For large-scale, single-storey buildings (e.g. airports) floor plans (and associated images) may be considered as tiled zones. But for the many of ubiquitous computing installations, a single map will often suffice.

The Behavior Configuration Page

The core aim of the recording process is to quickly encode behavior in space. To achieve this, behaviors are available as predefined buttons. These button labels are customizable along with their associated ‘event markers’, and stored in the log file. The button-labels will depend upon the nature of the experiment being performed. For example, in the case study described below, events included ‘Pause’, ‘Touch Bottle’, ‘Choose Bottle’, ‘Use Map’ and ‘Ask for Help’.

The Home/New Participant Page

The Home Page can configure additional recordings of GPS and audio recordings. Audio can be used by the experimenter to record observations or could be used by the participant using a ‘think aloud’ protocol. Once recording is started, the experimenter will generally turn to the core Map/Recording page (described below). Returning at the end of the experiment to press the stop button. This ends the audio/GPS recording process and exports all files.

The Mapping/Recording Page

At the heart of the App lies the Mapping and Recording Page. By tracing a finger or stylus over the map the location on the map will be recorded with the event-time. Experiments done by Kuhnmünch & Strube [14] show a high level of inter-operator agreement when manually recording positions in this way by trained operators. Events may be point-based: single discrete locations. This might be, for example, the position of casual conversation or locations when a technology is first noticed. Traces can also be linear, mirroring the movements/actions of a participant through space. While it might be thought that an ‘automatic marker’ technology might be preferable, it should be noted that automated indoor localization is difficult, at least without deploying specific markers in a building, and even then it is unable to co-record/co-locate user behaviors. The Mapping Page places the behavior-location at the foreground of the observation. By making the time-stamped tracing of locations simple the burden of recording of spatial events is greatly reduced.

First, in the lower region of the Mapping page are three rows of buttons. As each of the buttons is clicked, it records

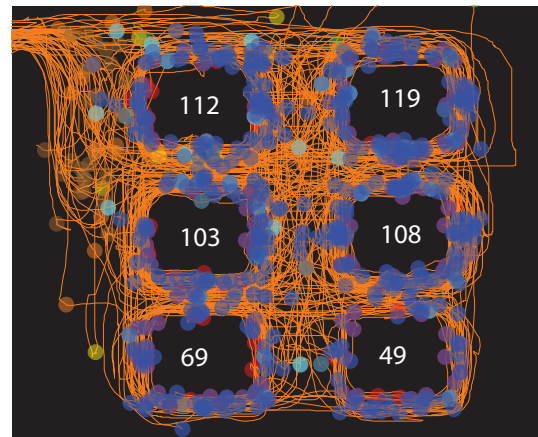


Figure 2 All participant paths (Orange lines) and pause points (blue) during experiment.

three things. The event or behavior in question, the time of that event and its last-known position on the map. This ‘event data’ is stored in a text log-file for later use and a uniquely colored, visual marker is also added to the map region, on the current floor, to indicate the behavior’s position in space. Next, compass directions can be stored: by pointing the iPad in a particular direction, it will record the iPad’s orientation at that location in time/space. E.g. this might be used to record the facing-direction (orientation) of the participant, or as a way of re-coding a participant’s presumed direction to a goal. It should be noted that compass readings might be influenced by nearby metallic objects, such as those used in building construction. Next, the ‘Audio Bookmark’ button appends the log-file with a spatial position to indicate where/when the experimenter or participant made some remark. This can be used to locate comments in a long, sparse audio file plus it can be used to geo-locate the utterance. Finally, the last button is a simple ‘Undo Button’ that removes the last event recorded.

The Analysis Page

The final page (see figure 2) is reserved for post-experiment data and interpretation. The Analysis Page is intended to be further expanded in future versions. Currently, this page overlays the trace data for all participants/trials in the current experiment. By using individual colored lines, the page visualizes the overlaid behaviors, co-located in space. From this, it is possible to rapidly notice locations where similar behaviors occur. The gesture of placing two fingers on the map draws a line between these points instructing the App to count the number of paths intersecting this threshold. It then displays the total count: e.g. “how many people walked this way?”

Evaluation

During the development process, we evaluated the software. In an initial experiment, reported in [4], cognitive scientists used the software to perform a wayfinding study in the Seattle Public Library [1]. Users needed as little as two hours to familiarize themselves with the App.

Afterwards; the prototype version was evaluated using the System Usability Scale (Score 71: 50th percentile or on a



Figure 3 Augmented popup wine-shop setup. LED lights indicating popularity

par with everyday products) and Microsoft Product Reaction Cards ('Straightforward' and 'Valuable' with 'Unpredictable' as the only negative response).

CASE STUDY

The case study involves, experiments reported in [10] of ambient intelligence. The objective of this experiment was to augment a real-world wine-shop with recommender technology see figure 3. The experiment took place in a large (8m x 10m) ambient laboratory converted into a 'popup' wine shop. The 'shop' consisted of 6 tables, each displaying 18 bottles of wine. Beneath each bottle, was a digitally controlled, color-LED base-light. The color beneath the bottle represented either the overall popularity of a wine or, after a bottle had been decisively selected, the 'co-purchase' relationship between that bottle and other bottles in the shop. Members of the public were invited to role-play wine-buying and select bottles with the incentive of being subsequently entered into a raffle to win some of the wine. While the experiment procedure regularly relocated the bottles to allow for the confounding aspect of the spatial position of the bottle, the actual impact of a bottle's spatial position became a key question. It should be noted that, during the experimental process, no informal observations noted any significant asymmetry in movement (of people or bottles). However, as an additional check, we decided to re-code the accompanying video data, using People Watcher as a post-hoc spatial coding tool.

Figure 2 shows the result of the first analysis of 26 participant paths. In Figure 2, the six tables are shown as the square 'holes' in movement; walls and a single doorway are also indicated on the plan. The visualization shows each participant as an orange line/path. From the initial analysis it seemed apparent that the bottom-right table was under-utilized. It is notable that participants were instructed to start from the middle row of tables and so were initially equidistant from the bottom and top-most tables. A Chi-

square test was conducted on the number of observed pause points (blue circles in Figure 2, counts shown per table) for each row of tables (Chi-square = 40.45, DF= 2, $p < .001$). This suggests that the observed pattern is not consistent with the first hypothesis of neutral and uniform use of space by the participants. This was reinforced by looking at the number of times a bottle was picked up for each row of tables (Chi-square = 17.48, DF = 2, $p < .001$). The value of this case study lies in the disparity between the initial intuition that the spatial layout was a neutral background to the experiment and the reality as revealed by People Watcher. It was only through this process of time-stamping and geo-locating spatial behaviors that the spatial asymmetry of people-flow was observed and later statistically verified. Possible causes and analyses of this are outside the scope of this paper but do show the utility of the software as an investigation tool.

CONCLUSION

In this paper we have argued that HCI's approach to space has, so far, been less than rigorous. By utilizing only vague methods to record the location of a user in the space we have created a situation where space is poorly described and so poorly understood. By having weak spatial-behavior recording tools it seems reasonable to have only a tentative understanding of the spatial variable. With the rise of post-desktop, ubiquitous computing the spatial variable can no longer be assumed neutral to the interaction process. We feel the only solution is to study and ultimately understand the effect of space and so help produce tools, methods, frameworks and theories that can inform these specific situations. To this end, we have presented People Watcher, a freely downloadable Application for the iPad. The case study demonstrates that while space might initially be thought unimportant to the ubiquitous computing technology of a wine shop, it has in fact highlighted spatial inconsistencies. This suggests that the use of this and similar Applications might create an area of supporting research giving rise to new theories, tools and methods.

REFERENCES

1. Ballendat, T., Marquardt, N., and Greenberg, S. Proxemic interaction: designing for a proximity and orientation-aware environment. *ACM Conf. on Interactive Tabletops and Surfaces*, (2010), 121–130.
2. Behrens, M., Fatah gen Schieck, A., Kostopoulou, E., et al. Exploring the effect of spatial layout on mediated urban interactions. *Proceedings of the 2nd ACM International Symposium on Pervasive Displays*, ACM (2013), 79–84.
3. Brewer, J. and Dourish, P. Storied spaces: Cultural accounts of mobility, technology, and environmental knowing. *International Journal of Human-Computer Studies* 66, 12 (2008), 963–976.
4. Dalton, N., Conroy Dalton, R., Hoelscher, C., and KuhnMünch, G. An iPad App for Recording Movement

- Paths and Associated Spatial Behaviors. *Proceedings of Spatial Cognition*, Springer Verlag (2012).
5. Dalton, N., Green, K., Marshall, P., et al. Ar-CHI-Tecture: architecture and interaction. *Proceedings of the 2012 ACM annual conference extended abstracts on Human Factors in Computing Systems Extended Abstracts*, (2012), 2743–2746.
 6. Dalton, N.S., Collins, E., and Marshall, P. Display Blindness?: Looking Again at the Visibility of Situated Displays Using Eye-tracking. *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*, ACM (2015), 3889–3898.
 7. Farrell, A.D. Computers and behavioral assessment: Current applications, future possibilities, and obstacles to routine use. *Behavioral Assessment*, (1991).
 8. Fischer, P.T. and Hornecker, E. *Urban HCI: Spatial Aspects in the Design of Shared Encounters for Media Façades*. submission, 2012.
 9. Fischer, P.T. and Hornecker, E. Urban HCI: spatial aspects in the design of shared encounters for media façades. *Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems*, (2012), 307–316.
 10. Garcia-Perate, G., Dalton, N., Conroy-Dalton, R., and Wilson, D. Ambient recommendations in the pop-up shop. *Proceedings of the 2013 ACM international joint conference on Pervasive and ubiquitous computing*, ACM (2013), 773–776.
 11. Hazlewood, W.R., Connelly, K., Makice, K., and Lim, Y. Exploring evaluation methods for ambient information systems. *CHI'08 extended abstracts on Human factors in comp sys*, (2008), 2973–2978.
 12. Ishii, H. Tangible bits: beyond pixels. *Proceedings of the 2nd international conference on Tangible and embedded interaction*, (2008), xv–xxv.
 13. Kahng, S. and Iwata, B.A. Computer systems for collecting real-time observational data. *Behavioral observation: Technology and applications in developmental disabilities*, (2000), 35–45.
 14. Kuhnmunch, G. and Strube, G. WayTracer: A mobile assistant for real-time logging of events and related positions. *Computers in Human Behavior* 25, 5 (2009), 1156–1164.
 15. O'Neill, E., Kostakos, V., Kindberg, T., et al. Instrumenting the city: Developing methods for observing and understanding the digital cityscape. *UbiComp 2006: Ubiquitous Computing*, (2006), 315–332.
 16. Parra, G., De Croon, R., Klerkx, J., and Duval, E. Quantifying the Interaction Stages of a Public Display Campaign in the Wild. *Proceedings of the 8th Nordic Conference on Human-Computer Interaction: Fun, Fast, Foundational*, ACM (2014), 757–760.
 17. Peponis, J., Conroy Dalton, R., Wineman, J., and Dalton, N. Measuring the Effects of Layout upon Visitors' Spatial Behaviors in Open Plan Exhibition Settings. *Environment and Planning B: Planning and Design* 31, (2004), 453–473.
 18. Rogers, Y., Hazlewood, W.R., Marshall, P., Dalton, N., and Hertrich, S. Ambient influence: can twinkly lights lure and abstract representations trigger behavioral change? *Proceedings of the 12th ACM international conference on Ubiquitous computing*, (2010), 261–270.
 19. Schroeter, R., Foth, M., and Satchell, C. People, Content, Location: Sweet Spotting Urban Screens for Situated Engagement. *Proceedings of the Designing Interactive Systems Conference*, ACM (2012), 146–155.
 20. Scupelli, P.G., Kiesler, S., and Fussell, S.R. Using isovist views to study placement of large displays in natural settings. *CHI '07 extended abstracts on Human factors in computing systems*, ACM (2007), 2645–2650.
 21. Weiser, M. and Brown, J.S. The coming age of calm technology. *Xerox PARC*. 8, (1996), 2007.
 22. Williams, A., Kabisch, E., and Dourish, P. From interaction to participation: Configuring space through embodied interaction. *UbiComp 2005: Ubiquitous Computing*, (2005), 903–903.
 23. Williamson, J.R. and Williamson, J. Analysing Pedestrian Traffic Around Public Displays. *Proceedings of The International Symposium on Pervasive Displays*, ACM (2014), 13:13–13:18.
 24. Wisneski, C., Ishii, H., Dahley, A., et al. Ambient displays: Turning architectural space into an interface between people and digital information. *Cooperative buildings: Integrating information, organization, and architecture*, (1998), 22–32.